BROOKHAVEN NATIONAL LABORATORY

Mission

Brookhaven National Lab cultivates positive and longstanding partnerships with researchers, academic institutes, industry, state and local governments.

The Licensing Portfolio

Available technologies in:

- Advanced Materials
- Biotechnology & Health
- Copyrights & Software
- Electronics & Instrumentation
- Energy
- Environment
- Nanotechnology

See the complete catalog of Brookhaven technologies available for licensing online:

www.bnl.gov/techtransfer

Tandem Van de Graaff Accelerator Facility

The Brookhaven National Laboratory Tandem Van de Graaff Facility consists of two 15-Megavolt electrostatic accelerators which can deliver ion beams of most elements (from 1 MeV protons to 337 MeV Gold ions) to various irradiation chambers available to users. Applications include the study of radiation effects on electronics for space applications, calibration of particle detectors, radiobiology studies, production of track-etched filter material, superconductor enhancements and high energy ion implantation in semiconductors.

Beam species	Atomic number	Mass number	Max Energy (MeV)
Hydrogen	1	1	28.75
Boron	5	11	85.5
Carbon	6	12	99.6
Oxygen	8	16	128
Fluorine	9	19	142
Magnesium	12	24	161
Silicon	14	28	187
Chlorine	17	35	212
Calcium	20	40	221
Titanium	22	48	232
Chromium	24	52	245
Iron	26	56	259
Nickel	28	58	270
Copper	29	63	277
Germanium	32	72	273
Bromine	35	81	287
Niobium	41	93	300
Silver	47	107	313
Iodine	53	127	322
Gold	79	197	337

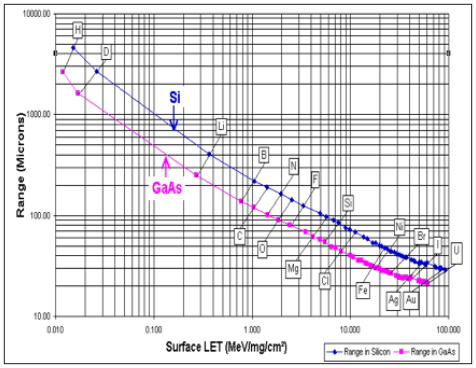
Example of available ions and maximum energies

BNL Tandem Van de Graaff

The Brookhaven National Laboratory's Tandem Van de Graaffs are the largest operational electrostatic accelerators in North America. A wide range of ion species and energies are delivered to the users on a full cost-recovery basis, mainly for industrial and space related applications. Rapid energy and ion changes, well controlled intensities, accurate dosimetry, high quality beams and extraordinary reliability make this a very versatile user friendly facility.

Space Radiation Effects Testing and Instrument Calibration

The Single Event Upset Test Facility (SEUTF) is available for the study of space radiation effects, in particular, Single Event Upset (SEU) Testing and Spacecraft Instrument Calibration. Ion beams of more than 50 ion species are provided over a wide range of energies and intensities. Our capabilities range from 1 MeV protons to 337 MeV Gold ions and Linear Energy Transfer (LET) in silicon from 0.01 to 91 MeV-cm^2/mg. The large automated test chamber contains accurate dosimetry and a positioning stage with laser alignment to ensure proper exposure of electronic parts.



Range vs Surface LET for some of the available ions

SEUTF Chamber and positioning stage

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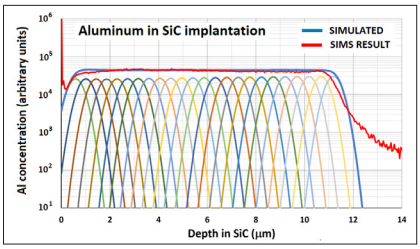
Ion Irradiation and Implantation

The BNL Tandems have been used to irradiate a wide variety of materials with heavy ions. A large diameter beam pipe and special chamber allow for large irradiation areas. Ion energies much higher than at most implanters open up a range of implantation depths not commonly available. Good dosimetry and fast energy changes result in efficient and accurate implantations. In particular, one application that is of increasing interest is the implantation of silicon carbide (SiC) wafers with ions such as aluminum, boron and nitrogen to maximum depths larger than 15 micrometers.



Simulated and actual depth profiles of aluminum implantation in SiC

Radiobiology Research Facility

Complementing the NASA Radiations Effects Facility (NSRL) at BNL, a lower ion energy radiobiology research facility was developed at the Tandem Van de Graaff. Low energies are appropriate to cover the range of maximum LET (the Bragg peak). Due to the ions short ranges, this is mainly useful to perform studies with thin samples such as cell cultures.

Special Projects

Many important R&D projects have been carried out by users of this facility. For example, electronic modules for the Mars Rovers were tested here. The effects of radiation on fiber optics, solar cells and solar sails have also been studied. The optical components of the Hubble Space Telescope were exposed to proton irradiation to make sure their properties will not be altered significantly in the space radiation environment. NASA, currently has two ongoing projects at the Tandem Van de Graaff. One is to calibrate and test the dosimeters for the International Space Station while the other is to test active space vehicle shielding for future manned space missions. At the same time, these accelerators have been used for many years as the heavy ion pre-injectors for two larger BNL user facilities (RHIC and NSRL).

Advantages of the BNL Tandem

- Widely used and trusted since 1988 by over 60 Companies, Laboratories and Agencies from North America, Europe and Asia
- 50 different ion species available
- Accurate dosimetry with a wide range of fluxes.
- Ion beams with continuously variable well-defined energies.
- Continuous or high intensity pulsed beams
- LET range in silicon from 0.01 to 91 MeV-cm^2/mg
- Large automated test chamber and accurate positioning stage with laser alignment
- High implantation energies.
- 15 minute changes between ion species
- 5 minute energy changes
- Flexible schedule
- User friendly hardware and software
- A highly experienced staff willing to work with users to customize the facility

One of two 15 MV Tandem Van de Graaffs

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